CMPS 312

Read Chapters 4, 19

Model-View-ViewModel (MVVM) Architecture

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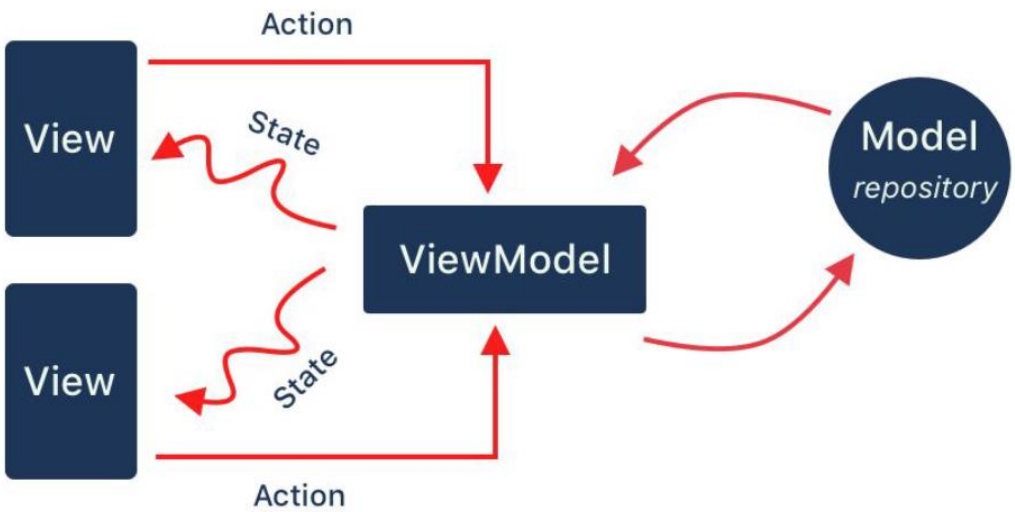
Outline

1. Model-View-ViewModel (MVVM)
2. ViewModel
3. LiveData
4. Flow

MVVM Architecture



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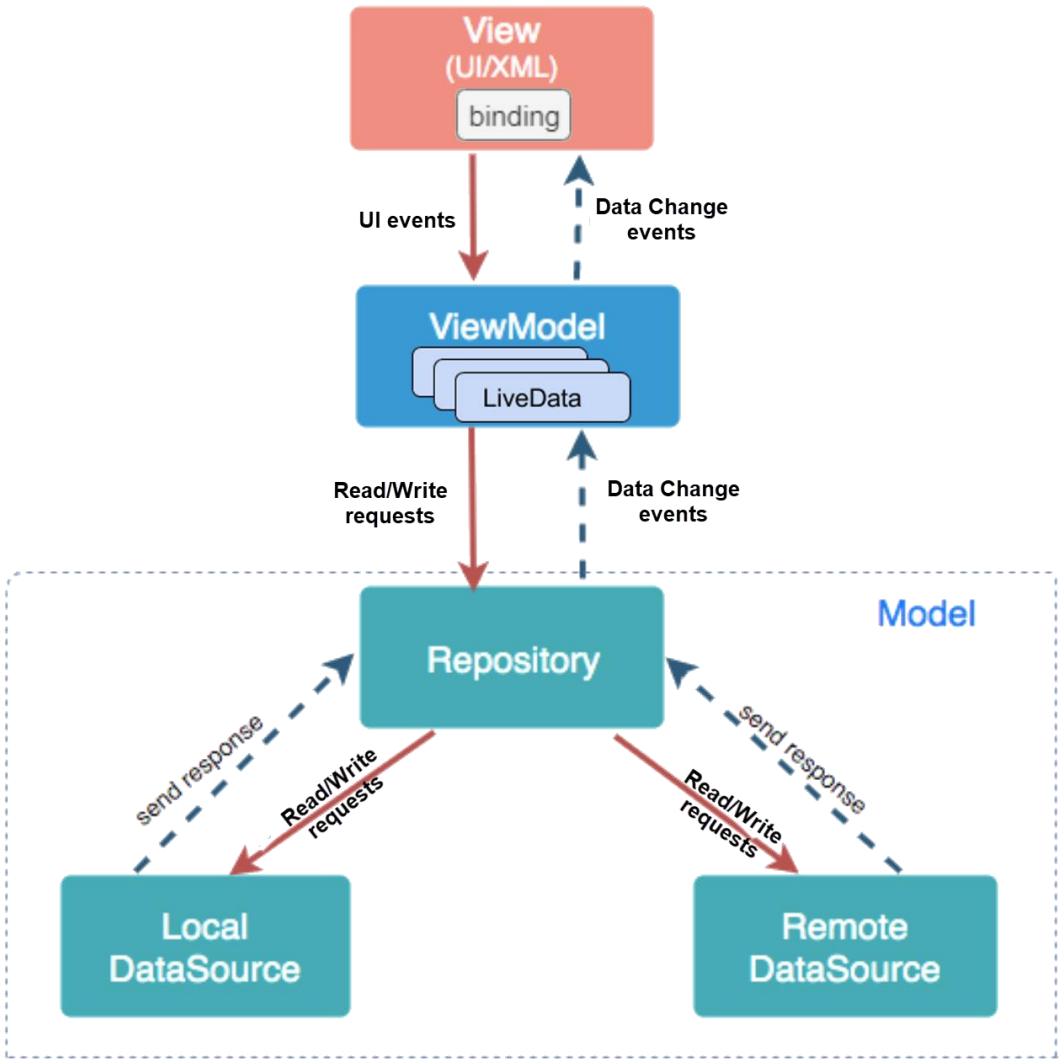
Model-View-ViewModel (MVVM) Architecture



View = UI to get input from the user.

It observes data changes from the ViewModel to update the UI accordingly

ViewModel

- Holds data needed for the UI
  - Interacts with the Model to read/write data based on user input
  - Notifies the view of data changes
- Implements UI logic / computation

Model - handles data operations

- Model has entities that represent app data
- Repositories read/write data from either a Local Database (using Room library) or a Remote Web API (using Retrofit library)
- Implements data-related logic / computation

MVVM Key Principles

- Separation of concerns:
  - View, ViewModel, and Model are **separate components** with distinct roles
- Loose coupling:
  - ViewModel has no direct reference to the View
  - View never accesses the model directly
  - Model unaware of the view
- Observer pattern:
  - View observes the ViewModel
  - ViewModel observes the Model
- Inversion of Control: *not covered in this course*
  - Uses Dependency Injection instead of direct instantiation of objects

Advantages of MVVM

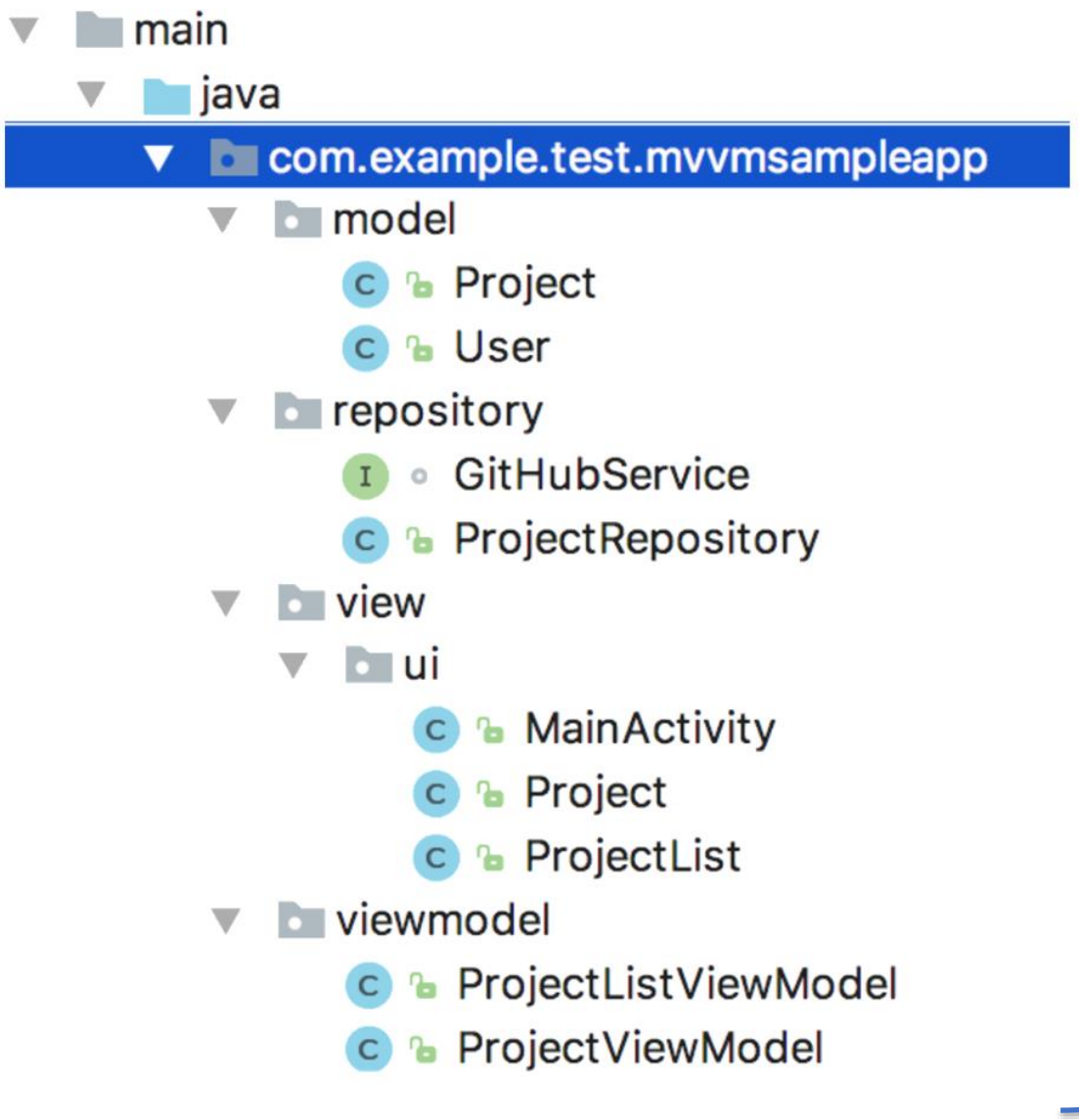
- ***Separation of concerns* = separate UI from app logic**
  - App logic is not intermixed with the UI. Consequently, code is cleaner, flexible and easier to understand and change
  - Allow changing a component without significantly disturbing the others (e.g., View can be completely changed without touching the model)
  - Easier **testing** of the App components

MVVM => Easily maintainable and testable app

Android Architecture Components

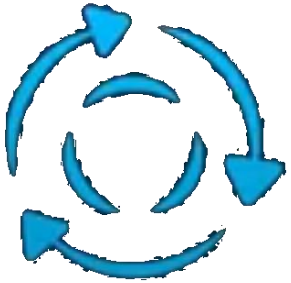
- Android architecture components are a collection of libraries to ease developing MVVM-based Apps
- Part of Android Jetpack They include:
  - ViewModel stores UI-related data that isn't destroyed on screen rotation
  - LiveData data holder that notifies the View when the underlying data changes
  - Room to read / write data to local SQLite database

Recommended Project Structure



You may organize the view by feature

ViewModel



Lifecycle Aware

Survives Config Changes

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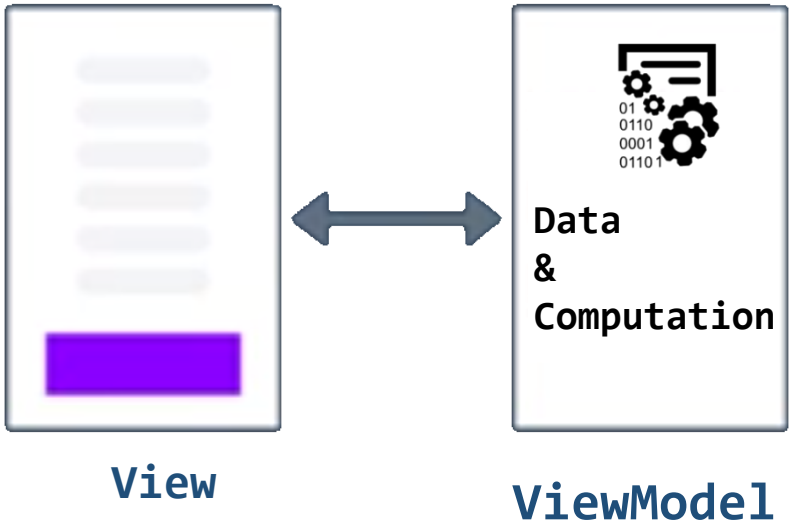
ViewModel

- ViewModel is used to **store and manage UI-related data**
  - in a lifecycle conscious way
  - allows data to survive device configuration changes such as *screen rotations* or *changing the device's language*

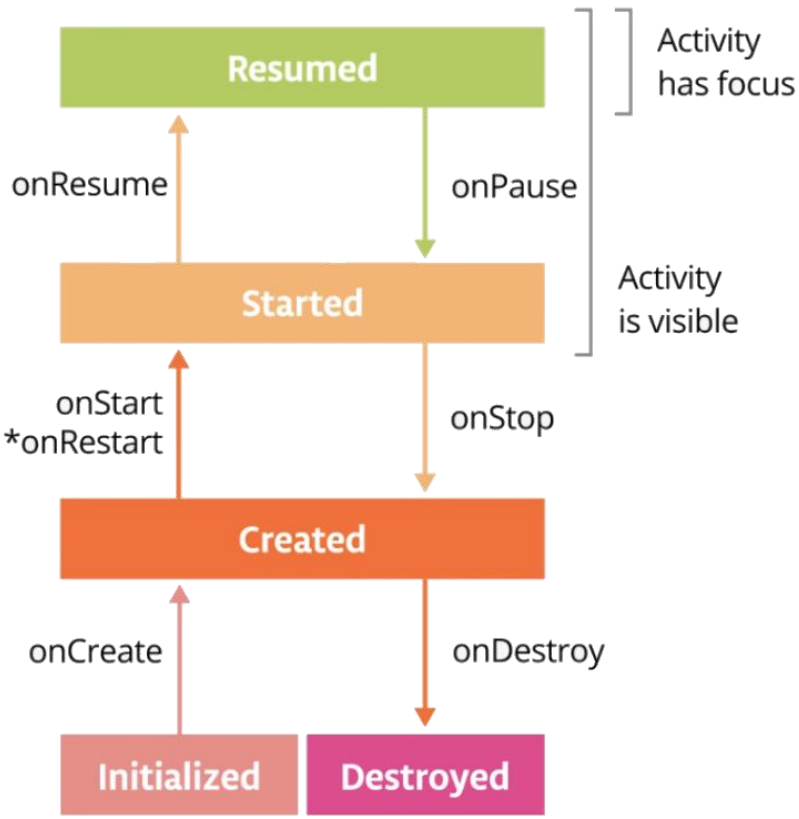


- If the system destroys or re-creates a UI component (e.g., when the screen rotates), any transient UI-related data you store in it is lost

User **ViewModel**:

- Store UI data
- Read/write data from a Repository

Activity Lifecycle

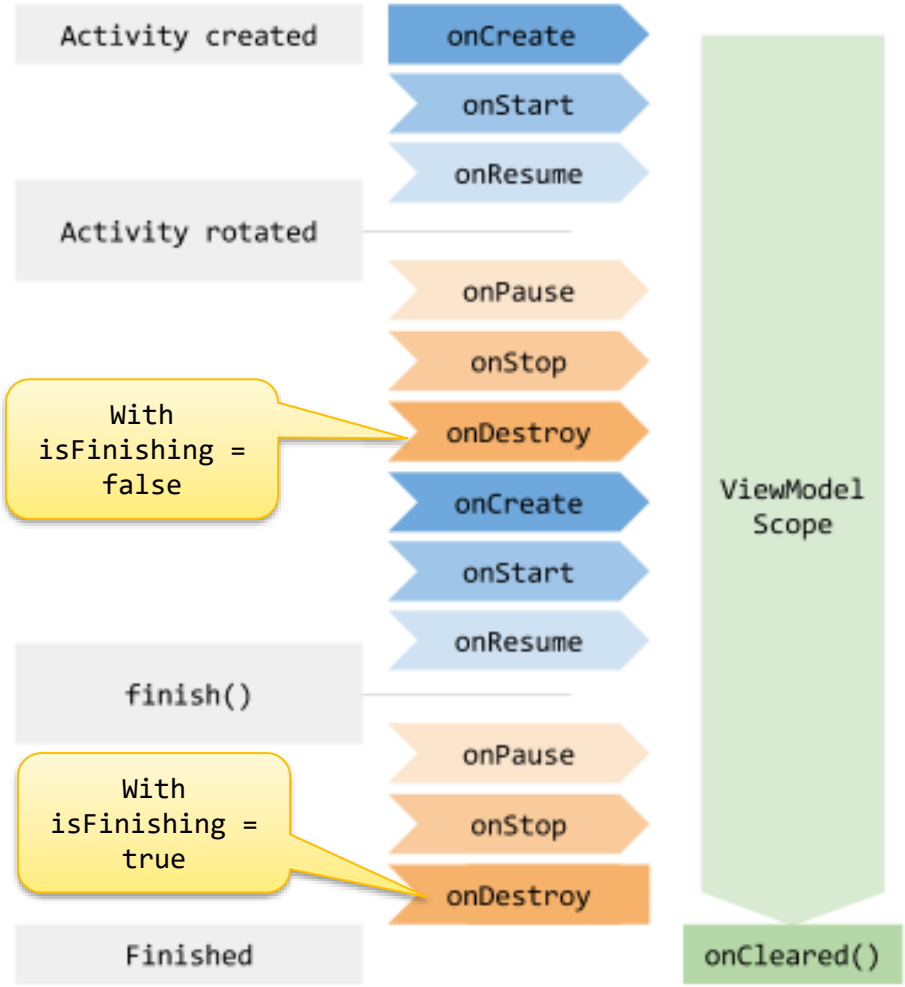


An activity has essentially **four states**:

- ***Resumed*** if the activity in the foreground of the screen (has focus)
- ***Started*** if the activity has lost focus but is still visible (e.g., beneath a dialog box).
  - When the user returns to the activity, it is **resumed**
- **Created** if the activity is completely obscured by another activity.
  - When the user navigates to the activity, it must be **restarted** and restored to its previous state.
- **Destroyed** when the user closes the app or if the activity is killed (when memory is needed or due to finish() being called on the activity)

ViewModel Lifecycle

- ViewModel object can bed scoped to the main activity
- However, it has a **longer lifespan** compared to the associated Activity which may undergo a rotation and get recreated
- It remains in memory until the activity is `completely destroyed`
  - When the activity is recreated (after a screen rotation) the associated ViewModel remains alive



ViewModel Example

```
class ScoreViewModel : ViewModel() {
    var team1Score = 0
    fun incrementTeam1Score() = team1Score++
}
/* From any screen you can get an instance of the shared viewModel
   Make the activity the store owner of the viewModel
   to ensure that the same viewModel instance is used for all screens
*/
val scoreViewModel = viewModel<ScoreViewModel>
        (viewModelStoreOwner = LocalContext.current as ComponentActivity)
val team1Score = scoreViewModel.team1Score
```

Need to add to build.gradle:

```
implementation "androidx.lifecycle:lifecycle-viewmodel-compose:2.4.0-beta01"
```

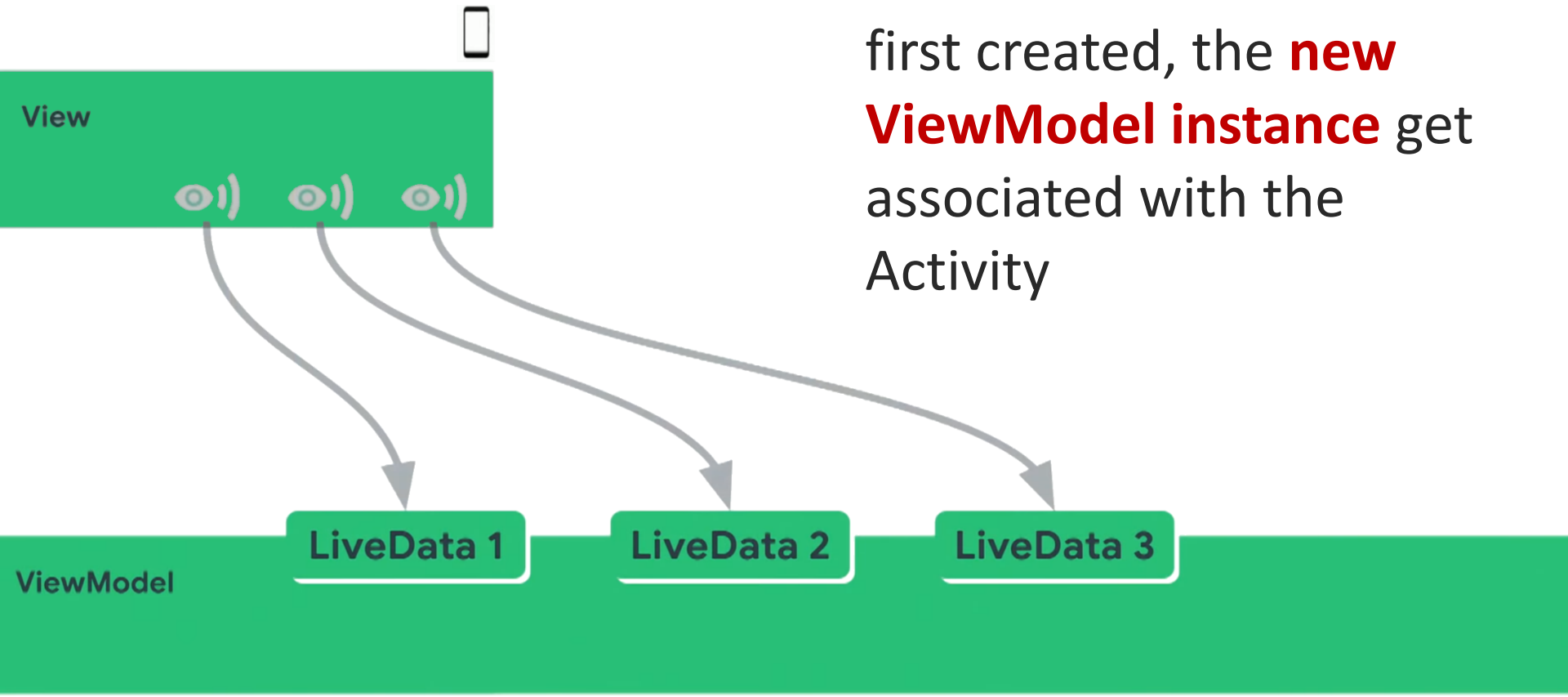
Associate ViewModel with the Activity

- Use **`viewModel()`** method to an instance of the ViewModel

```
val scoreViewModel = viewModel<ScoreViewModel>
        (viewModelStoreOwner = LocalContext.current as ComponentActivity)
```

  - For the first call, this creates and returns a new ViewModel instance and **associates it** with the Activity
  - For subsequent calls, it will return the pre-existing ViewModel associated with the Activity (e.g., MainActivity)
    - This is what preserves the data and maintains the connection with the **same** ViewModel

When the ViewModel is first Created

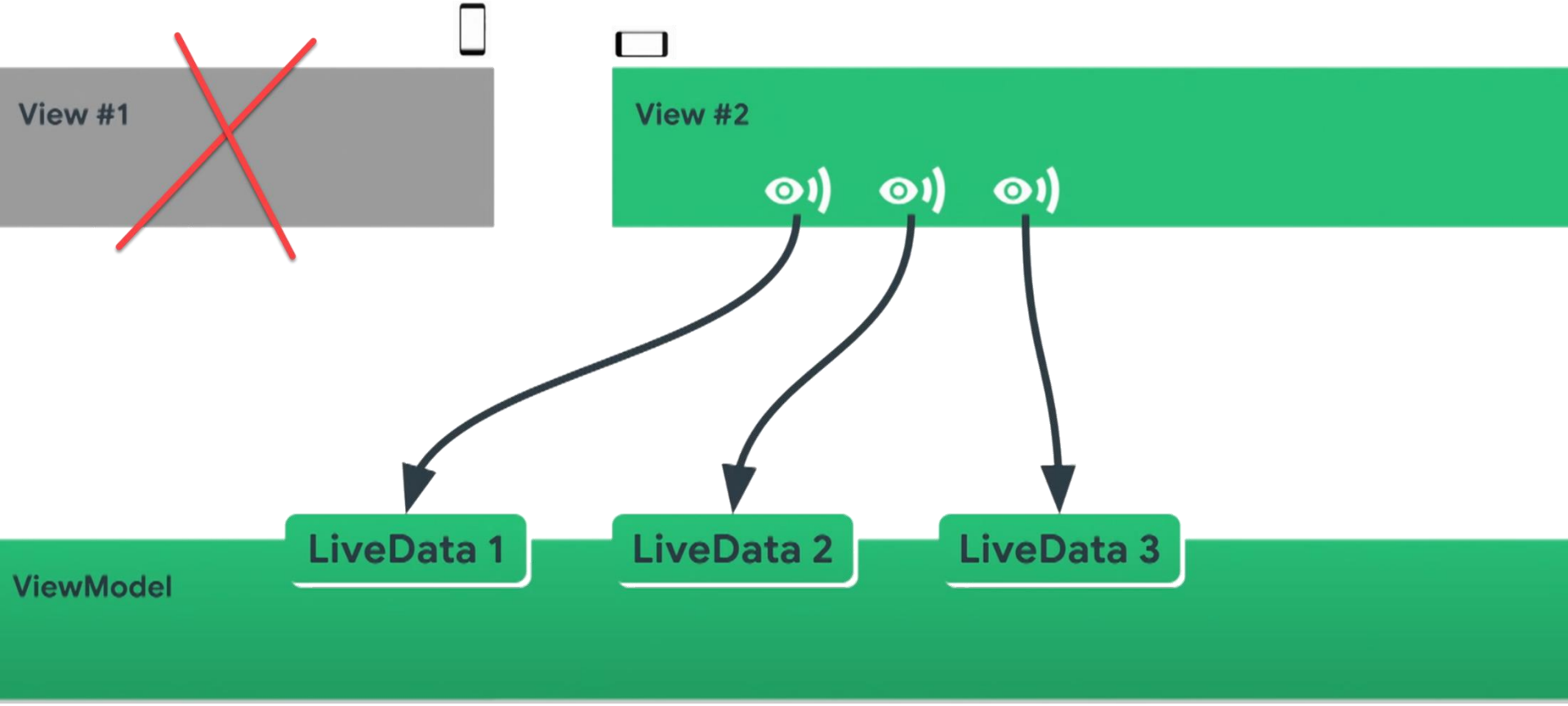


When the ViewModel is first created, the **new ViewModel instance** get associated with the Activity

Source: https://www.youtube.com/watch?v=B8ppnjGPAGE

OnConfig change (e.g., Screen Rotates)

OnConfig change, the Activity is destroyed, and a new instance of the Activity is created then it obtains **the same ViewModel instance used previously**



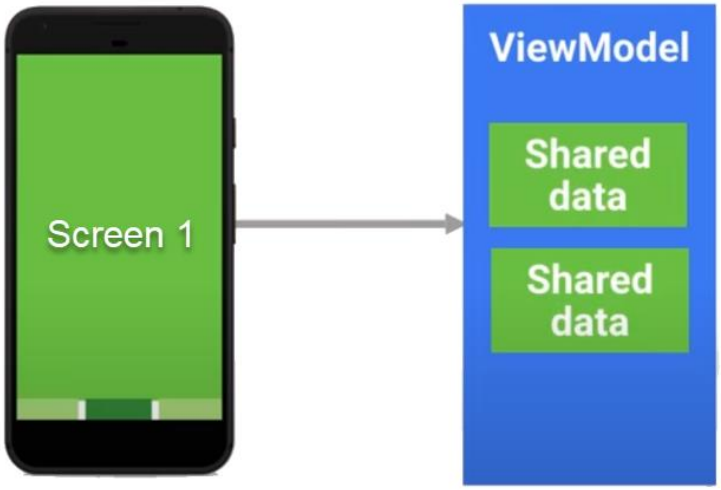
Source: https://www.youtube.com/watch?v=B8ppnjGPAGE

“no contexts in ViewModels” rule

- ViewModel should **not be aware of the View** who is interacting with
  => It should be decoupled from the View
  - ViewModel should not hold a reference to Activities or Views (i.e. Composables)
  - Should not have any Android framework related code
  - As this defeats the purpose of separating the UI from the data
  - Can lead to memory leaks and crashes (due to null pointer exceptions) as the ViewModel outlives the View
    - if you rotate an Activity 3 times, 3 three different Activity instances will be created, but you only have one ViewModel instance

Shared data between Screens using ViewModel

- Screens can **share** data using a shared **View Model** class that extends `ViewModel()`




```
@Composable
fun ProfileScreen(userId: Int) {
 /* Get an instance of the shared viewModel
   Make the activity the store owner of the viewModel
   to ensure that the same viewModel instance is used for all screens */
 val userViewModel = viewModel<UserViewModel>(viewModelStoreOwner =
 LocalContext.current as ComponentActivity)
 val user = userViewModel.getUser(userId)
... }
```

LiveData

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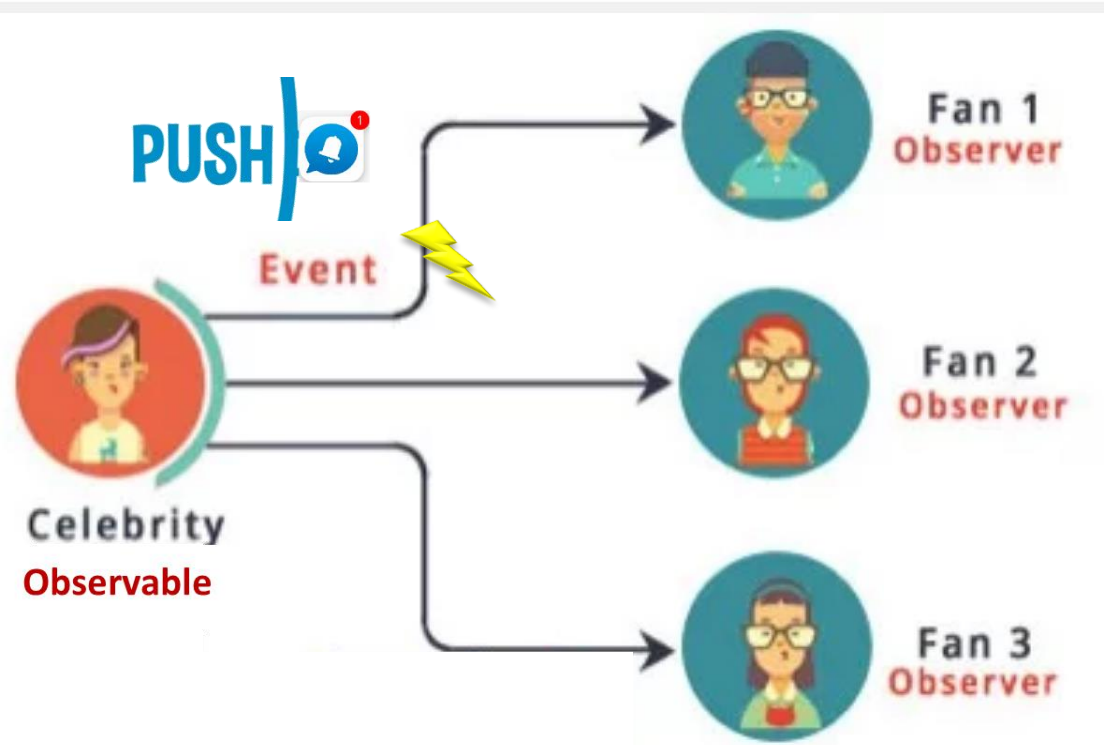
LiveData

- LiveData is an **observable data holder**: **active** observers (i.e., the View) get notified when data change
- The view can observe LiveData objects for changes without creating **explicit and rigid dependency** between them
  - This decouples completely the LiveData object producer from the LiveData object consumer
  - ViewModel exposes its data using **LiveData** that the View can observe and update the UI accordingly

Observable - Real-Life Example

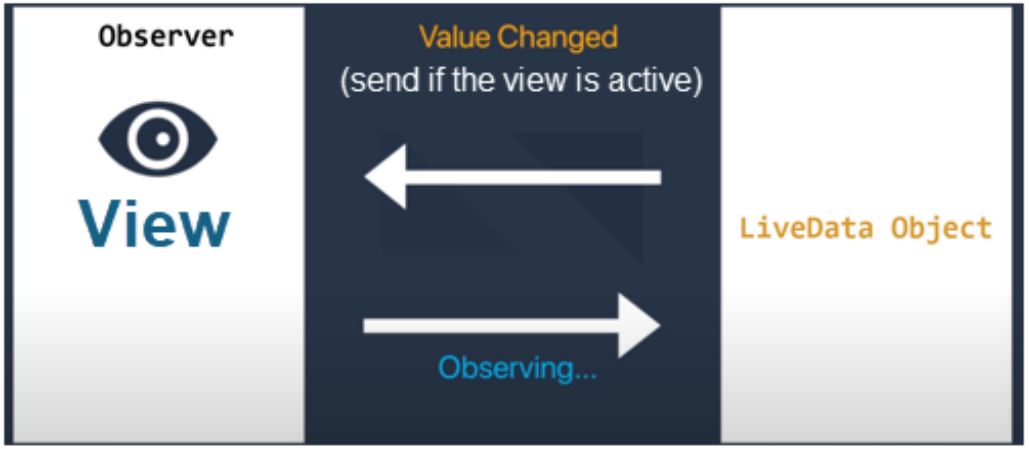
- A celebrity who has many fans on Instagram. Fans want to get all the latest updates (photos, videos, posts etc.). Here fans are **Observers** and celebrity is an **Observable** (called **LiveData** on Android)



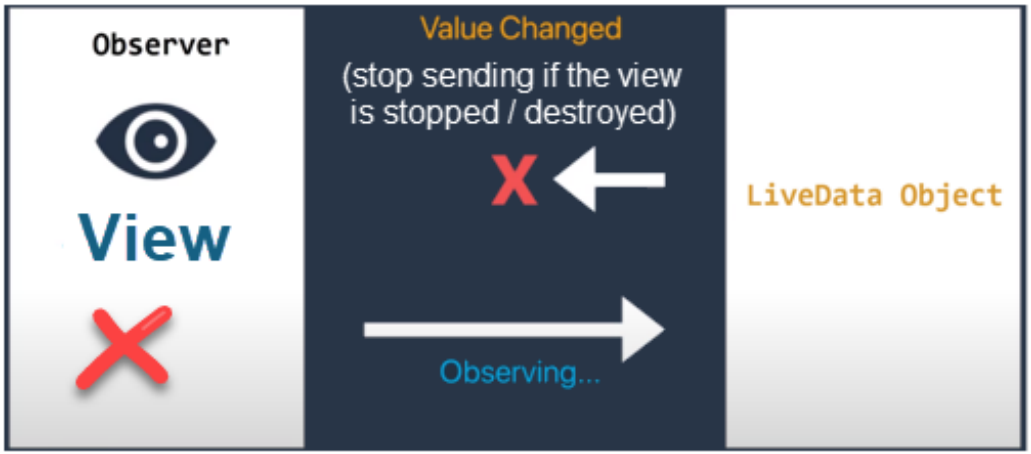
LiveData is lifecycle-aware

LiveData is aware of the Lifecycle of its Observer

- Notifies data changes to only **active** observers (Stopped/Destroyed View will NOT receive updates)

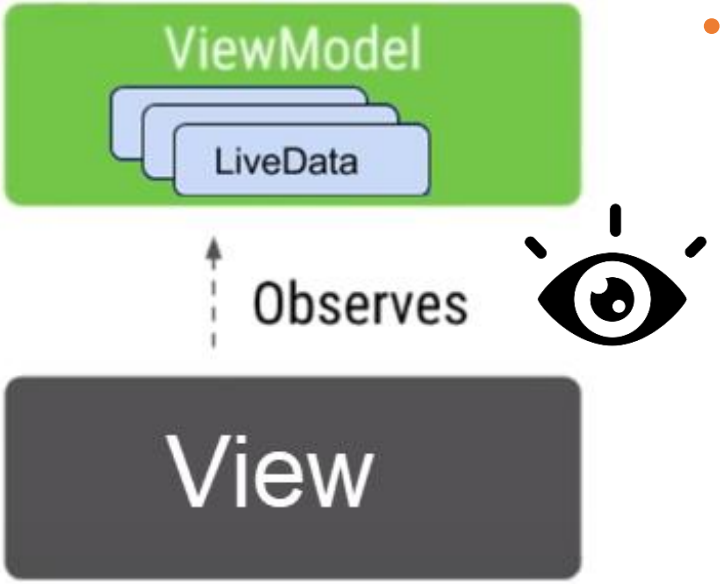


- It automatically removes the subscription when the observer is destroyed so it will not get any updates



LiveData in Code

LiveData **warps around** an object and allows the view to **observe** it



- ViewModel expose LiveData objects that the View can observe

```
class MainActivityViewModel : ViewModel() {
    private val _team1Score = MutableLiveData<Int>(0)

    // Expose read only LiveData that the View can observe or bind to
    val team1Score: LiveData<Int> get() = _team1Score

    fun incrementTeam1Score() {
       // call postValue to notify Observers
       _team1Score.value = (_team1Score.value ?: 0) + 1)
    }
}
```

- View **observes** LiveData changes

```
class MainActivity : AppCompatActivity() {
    // onCreate
    // Associate the Activity with the ViewModel
    val viewModel by viewModels<MainActivityViewModel>()

    viewModel.team1Score.observe(this) {
          team1ScoreTv.text = it.toString()
    }
}
```

Flow

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What is Flow?

🌊 Stream of values (produced one at a time instead of all at once)

- 🌊 Values could be generated from network requests or database calls

🌊 Can transform a flow using operators like map, switchMap, etc

```
fun stream(): Flow<String> = flow {
    emit("🌊") // Emits the value upstream ☝️
    emit("🎡")
    emit("🍕")
}
```

Return Flow: Stream of Data


```
object WeatherRepository {
    private val weatherConditions = listOf("Sunny", "Windy", "Rainy", "Snowy")
    fun fetchWeatherFlow(): Flow<String> =
        flow {
            var counter = 0
            while (true) {
                counter++
                delay(2800)
                emit(weatherConditions[counter % weatherConditions.size])
            }
        }
}
```

```
val currentWeatherFlow: LiveData<String> =
        WeatherRepository.fetchWeatherFlow().asLiveData()
```

Flow Operators

- Flow has operators similar to collections such as map, filter and reduce

```
(1..5).asFlow()
    .filter { it % 2 == 0 }
    .map { it * it }
    .collect { println(it.toString()) }

val result =(1..5).asFlow()
                    .reduce { a, b -> a + b }
println("result: $result")
```

Resources

- MVVM
  - https://developer.android.com/jetpack/guide
  - https://medium.com/androiddevelopers/viewmodels-a-simple-example-ed5ac416317e
- Data Binding
  - https://developer.android.com/topic/libraries/data-binding
- Data Binding codelab
  - https://codelabs.developers.google.com/codelabs/android-databinding